To,
The Director (Research)
Maharshi Dayanand Saraswati University,
Ajmer-305001 (Rajasthan)

Through – Principal, S.P.C. Government College, Ajmer.

Sub : Submission of Revised Synopsis in Chemistry.

Sir,

I am submitting four copies of synopsis **entitled "Study and analysis of corrosion inhibitory effects of aerial parts of Tinospora cordifolia on metals tin and copper in different acidic media like HCl, H_2SO_4 and HNO_3"** for registration of Ph.D. in Chemistry under Supervision of **Dr. Alok Chaturvedi**, Lecturer, S.P.C. Government College, Ajmer.

Kindly acknowledge the same.

M.D.S. University, Ajmer
Receipt No.
Date 21-8-18

Yours sincerely,

Vineeta Mandawara

(Vineeta Mandawara)
Research Scholar

3989 / 21/8/18
राजकीय महाविद्यालय, अजमेर
क्र : एफ-5/अका.1/जीसीए/20 दिनांक
निदेशक (शोध)
को आवश्यक कार्यवाही हेतु प्रेषित है
उप आचार्य
राजकीय महाविद्यालय, अजमेर

20/8/18

(Dr. Alok Chaturvedi)
Lecturer (Selection Grade)
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Lecturer
Govt. College, Ajmer

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STUDY AND ANALYSIS OF CORROSION INHIBITORY EFFECTS OF AERIAL PARTS OF *TINOSPORA CORDIFOLIA ON METALS TIN AND COPPER IN DIFFERENT ACIDIC MEDIA AS HCL,H_2SO_4 AND HNO_3*

विभिन्न अम्लीय माध्यमों में धातु टिन एवं कॉपर पर टिनोस्पोरा कोर्डिफोलिया के वायवीय भागों के संक्षारण निरोधी प्रभावों का अध्ययन एवं विश्लेषण

A

SYNOPSIS

Submitted for the Award of Ph.D. degree of

Maharshi Dayanand Saraswati University, Ajmer

in the Faculty of Science (Chemistry)

By

Ms. **Vineeta Mandawara**

Under Supervision of

Dr. Alok Chaturvedi

Lecturer (Selection Scale)

Department of Chemistry

S.P.C. Govt. College, Ajmer

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APPENDIX-IV

Format for outline of Proposed Research Work
(To be supplied in Eight Copies)

1. Name of Scholar

   (in English) : Ms. VINEETA MANDAWARA

   (in Hindi) : कु. विनिता मण्डावरा

2. Title of Research Work :

   (in English) : STUDY AND ANALYSIS OF CORROSION INHIBITORY EFFECTS OF AERIAL PARTS OF TINOSPORA CORDIFOLIA *ON METALS TIN AND COPPER IN DIFFERENT ACIDIC MEDIA AS* HCL, H_2SO_4 *AND* HNO_3

   (in Hindi) : विभिन्न अम्लीय माध्यमों में धातु टिन एवं कॉपर पर टिनोस्पोरा कोर्डिफोलिया के वायवीय भागों के संक्षारण निरोधी प्रभावों का अध्ययन एवं विश्लेषण

3. Location : DEPARTMENT OF CHEMISTRY, S.P.C. GOVT. COLLEGE, AJMER

4. Importance of proposed Investigation, Objectives : Annexure-I

5. Review of work already done on the subject : of proposed research study Annexure-II

6. Research gaps identified in the proposed : field of investigation Annexure-III

7. Major Hypothesis, If any : Annexure-IV

8. Research Methodology : Annexure-V

9. Bibliography : Annexure-VI

20/8

Name & Signature of Supervisor with date & seal

Dr. Prithviraj Chauhan
Govt. College, Ajmer

Vineeta Mandawara

Signature of Candidate with date 21/08/18

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Annexure-I

IMPORTANCE OF PROPOSED INVESTIGATION

Corrosion is an undesirable natural process and found to be destructive process, which badly affects metals and alloys. The use of corrosion inhibitors is the most economical and practical method for reducing corrosion on metals and alloys in acidic media[1-3].

In acidic media, oxidation of metals generally occurs and hydrogen gas evolved during the reaction. Corrosion is natural degradation process of metals and alloys surfaces due to the attack of atmospheric gases, moisture and other chemicals[4-5].

Industries depends mainly on the use of metals and alloys. Corrosion of metals is the major problem in industries, so the use of corrosion inhibitors is the easiest and cheapest method to prevent corrosion. These inhibitors slow down the corrosion rate and thus prevent monetary losses.[6-7]

The corrosion inhibitors should have some characteristics like :-

(1) They should be capable of reducing corrosion rate.
(2) They should not have any side effects.
(3) They should be eco-friendly and easily available.
(4) They should be non-toxic.

A large number of organic compounds having heteroatom acts as effective inhibitors and found to have anticorrosive characters but at the same time, they are highly toxic, costly and harmful for both living beings and environment[6].

Many researches have been done for investigating natural products or plant materials as effective corrosion inhibitors, which are cheaper, non-toxic, renewable and environment friendly [8-16].

OBJECTIVES

The objectives of proposed investigation are to search the corrosion inhibition efficiency of plant extracts of *tinospora cordifolia,* which are eco-friendly, environmentally safe and have low-cost, for the metals such as tin and copper in different acidic media and acidic concentrations.

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Main objectives are as follows :

(1) To investigate natural products as potential corrosion inhibitor.

(2) To obtain the extract of leaves and stem of *tinospora cordifolia* by soxhlet unit.

(3) To use extract of leaves and stem as corrosion inhibitor.

(4) To observe corrosion inhibition and efficiency of extract of *tinospora cordifolia* on different metals in different acidic media (nitric acid, sulphuric acid and hydrochloric acid) in different concentrations of acids using additives such as $NaNO_3$,Na_2SO_4 and NaCl.

(5) To monitor corrosion rate and percentage inhibition efficiency at different concentrations of acid and at different concentrations of corrosion inhibitor (plant extract).

(6) To analyze the plant extract as antiviral, antifungal and antibacterial agent.

(7) To analyze the toxicity of plant extract.

(8) To analyze the corrosion and percentage inhibition efficiency by using the weight loss method and thermometric method.

(9) To compare corrosion inhibition efficiency of *tinospora cordifolia* extract with Schiff bases and mannich bases (traditional corrosion inhibitors).

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Annexure-II

REVIEW OF WORK ALREADY DONE ON THE SUBJECT OF PROPOSED RESEARCH STUDY

As organic inhibitors are highly toxic and harmful to the environment, a number of researches have been done for investigating natural products of plant origin, as effective corrosion inhibitors.

Natural products extracted from plants are found to be effective and efficient corrosion inhibitors. Extracts of natural products like, *Punica granatum* (pomegranate)[17], *Emblica officinalis*[18], phyllanthus amarus[19], black pepper[20-22] extract and fenugreek seeds[23] and leaves have been tested as corrosion inhibitors for metals.

Cuminum cyminum[24] (Jeera) extract serves as an eco-friendly inhibitor for the corrosion of mild steel in sea water. Aqueous extract of *rhizome powder*[25] and *beetroot*[26] also investigated as good corrosion inhibitors.

Loto reported the inhibition efficiency of *vernonia amygdalina*[27] (bitter leaf) on the corrosion of mild steel in 0.5M HCl solution. The gum exudates from *Acacia*[28] species, was investigated and found to be good inhibitor for the corrosion of mild steel in fresh water. The ethanolic extract of *honey*[29] and *calotropis*[30], also found to be good corrosion inhibitors for zinc and aluminium in acidic media.

The aqueous extract of the leaves of *henna*[31] (lawsonia) is tested as corrosion inhibitor of C-steel, nickel and zinc in acidic, neutral and alkaline solution. Extract of *ginger*[32] also has been evaluated as a green inhibitor for the corrosion of steel in sulphide polluted salt water.

Quraishi et al[33] and Chouhan & Gunasekaran[34] investigated the corrosion inhibition efficiency of *Murraya koenigii* (curry leaves) and *Zanthoxylum alatum*, respectively for mild steel in acidic media (HCl & H_2SO_4).

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Sethuraman and Bothi Raja investigated the corrosion inhibition efficiency of *Datura metel*[35] in acid medium on mild steel. Similarly *piper nigrum*[36] leaves extract was reported as an effective corrosion inhibitor for steel in citric acid. A comparative study[37] of the inhibitory effect of the extracts of *Ocimum sanctum*, *Aegle marmelos* and *Solanum trilobatum* on the corrosion of mild steel in 1N Hcl was done and ocimum with maximum 97% inhibition efficiency was found to be the most efficient corrosion inhibitor.,

Aloe vera[38] extract acts as green corrosion inhibitor for mild steel in HNO_3 and *opuntia*[39] extract inhibits the corrosion of aluminium in HCl solution with 96% inhibition efficiency. Plant extracts of *Argemone maxicana*[40], *peepal*[41], *Carica papaya*[42], *Garlic*[43], *Hibiscus*[44], *tobacco*[45], *Delonix regia*[46] and stem extract of *Brahmi*[47] has been investigated and found to be good corrosion inhibitors.

Several studies proved that organic compounds containing heteroatoms like N, S and O show efficient corrosion inhibition properties but at the same time, they are costly and harmful to both living beings and environment. On the other hand, plant extracts have very high inhibition efficiency[48] and hence termed as green corrosion inhibitors[49-50] which are biodegradable, cheap, non-toxic and eco-friendly[51].

Recently, Sangetha et al[52] and Johnsirani et al[53] have published review reports on the use of extracts of flowers and natural dyes as corrosion inhibitors. Similarly, the *bamboo*[54-55] leaves extracts have been reported as good inhibitors for steel in HCl solution. Corrosion inhibition of *Azadirachta indica*[56] mature leaves extract as green inhibitor for mild steel in HNO_3 acid solution, also has been investigated.

The corrosion inhibition efficiency of leaves extract of *Withania somnifera*[57] (Ashwagandha) on aluminium in HCl solution was investigated. The study reveals that, inhibitor works excellently at its concentration of 0.8% for 2N HCl with maximum efficiency of 99.28%.

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Annexure-III

RESEARCH GAPS IDENTIFIED IN PROPOSED FIELD OF INVESTIGATION

Many organic compounds have been reported as good and effective corrosion inhibitors due to the presence of heteroatoms like N, O, S, P, and having higher electron density and basicity. But being toxic in nature, the present need is to, develop eco-friendly, non-toxic, cheap and renewable corrosion inhibitors[48-51].

A number of *heterocyclic*[58-62] compounds and their derivatives have been reported as effective corrosion inhibitors. *Schiff bases*[63-66] also use as an effective corrosion inhibitors. A few *Mannich bases*[67-69] also has been studied as corrosion inhibitors.

Researches proved that many natural products (plants extract) has been proved to be effective corrosion inhibitors. These natural products or plant extracts are biodegradable, environment friendly, cheap, non-toxic and non-pollutant.

Survey of literature reveals that, extract of *tinospora cordifolia* is widely used in medicines, however its corrosion inhibitory effect is yet unknown. In the proposed investigation *tinospora cordifolia* extract will be used as corrosion inhibitor in different acidic media like sulphuric acid (H_2SO_4), Nitric acid (HNO_3) and hydrochloric acid (HCl) on tin and copper etc.

Leaves and stem extract of *tinospora cordifolia* will be used as green corrosion inhibitor on different metals as tin and copper in different acidic media (HCl, H_2SO_4, HNO_3) of different acid concentrations.

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Annexure-IV

MAJOR HYPOTHESIS, IF ANY

Corrosion of metals, is undesirable[2], spontaneous and thermodynamically favourable process[6]. Because of corrosion, every year 5% GNP of our country is lost. A study in the industrial sector of the United States of America, reported that 121 billion dollars has been spent annually on corrosion methods as well as several billions lost to corrosion activities. However 40-50% of corrosion can be controlled by using appropriate corrosion inhibitors.

Natural products or plant extracts can be used as corrosion inhibitors, as these are abundantly available, non-toxic, cheaper and environment friendly. Therefore, *tinospora cordifolia* has been selected to study its corrosion inhibition efficiency. It is easily available in any season. It is found throughout India and also in Sri Lanka, Bangladesh, Myanmar, China, Southern Eastern Asia, Africa and Australia. It is seen growing in all dry and deciduous forests of India.

Classification :

Kingdom	:	Plantae
Sub-Kingdom	:	Tracheobionta
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Sub-class	:	Ranunculidae
Order	:	Ranunculales
Family	:	Menispermaceae
Genus	:	Tinospora
Species	:	Cordifolia

It is used for the treatment of intermittent fevers, chronic fevers, burning sensation, gout, inflammations, cough, Asthma, diabetes, urinary infections, jaundice, leprosy, anaemia, cardic debility, skin diseases, chronic diarrhoea and dysentary etc.

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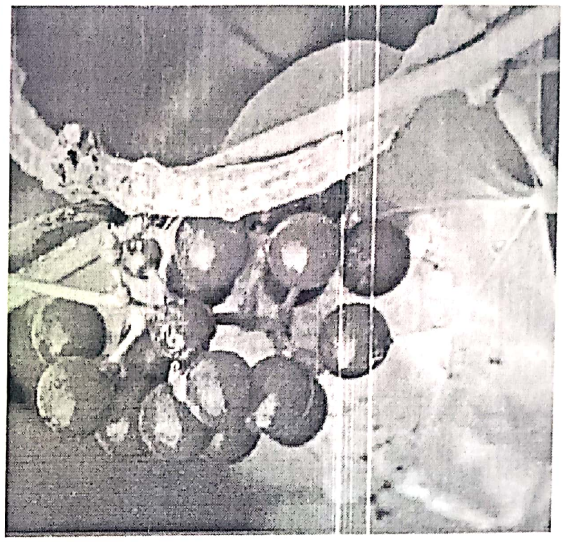
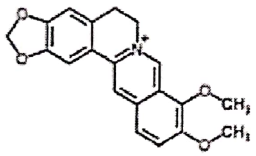
It is commonly known as "guduchi" or "Amrita". In Hindi, it is known as "*Giloy*". In Sanskrit Giloy is known as "*Amrita*" which literally means the root of immortality because of its abundant medicinal properties.

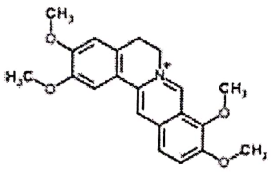


It contains different constituents[70] such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoids, phenols, aliphatic compounds and polysacharides etc.

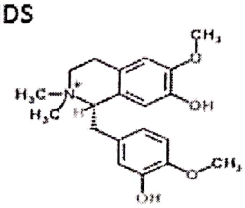
ALKALOIDS



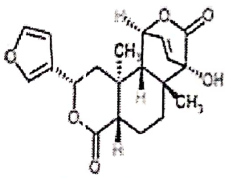
BERBERINE



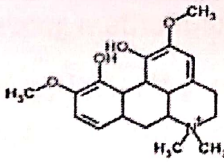
PALMATINE



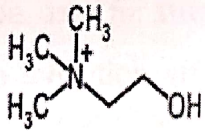
TEMBETARINE



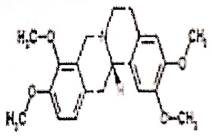
ISOCOLUMBIN



MAGNOFLORINE



CHOLINE



TETRAHYDROPALMATINE

Corrosion inhibition properties of *tinospora cordifolia* for different metals (tin and copper) yet to be investigated in different acidic media (HCl, HNO_3 and H_2SO_4) using some additives like NaCl,$NaNO_3$ and Na_2SO_4.

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Annexure-V

RESEARCH METHODOLOGY

The corrosion inhibition efficiency and corrosion rate of *tinospora cordifolia* will be calculated by using weight loss method and thermometric method.[72]

1. In weight loss method, metal pieces of equal dimensions will exposed to acidic solution. After a definite time period, metal piece will be taken out, washed and dried. Finally, weight of each metal piece will take and by using formula, percentage inhibition efficiency of plant extract will calculate[72-73] as :-

$$\underset{\text{(\% inhibition efficiency)}}{IE\ \%} = \frac{\Delta Wu - \Delta wi}{\Delta Wu} \times 100$$

Where ΔWu is weight loss of metal in acid solution, in the absence of inhibitor and ΔWi is weight loss of metal in acid solution, in the presence of inhibitor of known amount.

2. In thermometric method, the metal piece is immersed in a beaker containing acid and inhibitor along with thermometric bulb, which is immersed in Dewar flask. Reaction number can be calculated as :-

$$\text{Reaction number} = \frac{Tm - Ti}{t}$$

Where Tm is maximum temperature, Ti is initial temperature and t is the time in minutes require attaining maximum temperature.

Following methodology will be used for study:-

1. To investigate the corrosion inhibition efficiency of *tinospora cordifolia extract on metals tin and copper in different acidic media like* HCl, H_2SO_4 *and* HNO_3 *of different concentrations,using some additives such as* $NaCl, Na_2SO_4$ *and* $NaNO_3$.

2. *Identification and investigation for finding binding capacities of corrosion inhibitor by element analysis(C,H,N) and spectral analysis methods like IR and NMR.*

3. Comparison of corrosion inhibition efficiency of *tinospora cordifolia* extract will be done with *Schiff base and mannich base (synthetic corrosion inhibitor).*

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CHAPTERWISE DETAILS OF PROPOSED RESEARCH WORK

Chapter 1	-	Introduction
Chapter 2	-	Review of Literature
Chapter 3	-	Experimental (Methods and Materials)
Chapter 4	-	Result and Discussion
		Corrosion monitoring for metals in acidic media
Chapter 5	-	Summary
		Bibliography

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BIBLIOGRAPHY

1. G. Trabanelli; corrosion **47**, (1991), 410-9. https://doi.org/10.5006/1.3585271
2. N. Karthiga, S. Rajendran, P. Prabhakar, R.J. Rathish, Int. J. Nano corros. Sci. Engg. **2 (4)**, (2015), pp 31-49.
3. M.S. Al-Qtaibi, A.M. Al-Mayouf, M. Khan, A.A. Mousa, S.A. Al Mazroa, H.Z. Alkhathlam, Arabian J. of Chem. **(7)**, (2014), pp 340-346.
4. Devarayan Kesavan, Maya Krishnan Gopiraman, Nagaranjan Sulochana, Chem. Sci., Rev. Lett. **1 (1)**, (2012), pp 1-8.
5. K. Ramya and N. Murali Mohan, Int. J. Chem. Concepts, **2 (2)**, (2016), pp 70-75.
6. Nena Patni, Shruti Agarwal, pallavi Shah, Chinese Journal of Engineering, Vol. 2013, Article ID 784186.
7. Marko Chigondo & Fidelis Chigordo, Journal of Chemistry, Vol. 2016, Article ID 6208937.
8. L.A. Nnanna, B.N. Onwuagba, I.M. Mejeha & K.B. Okeoma; African J. of Pure and Applied Chem., **4 (1)**, (2010), pp 011-016.
9. R. Saratha and R. Meenakshi, Asian Journal of Chemistry, **25 (3)**, (2013), pp 1415-1419.
10. V.J. Ekpe, E.E. Ebenso and U.K. Ibok, J.W. African Sci. Assoc. **39**, (1994), pp 13-30.
11. G.O. Avwtri and F.O. Igho, Materials Letlore, Vol. **59**, No. 22-23 (2003), pp 3705-3711.
12. S.J. Zakvi and G.N. Mehta, Trans SAEST, **24,** (1968), pp 407.
13. A.S. Verma and G.N. Mehta, SAEST, **89** (1997).
14. G.S. Verma, P. Antony and S.P. Mathur, J. Electrochem, Soc. India, **53**, (2002), pp 173.
15. A. Bouyanzer and B. hannanut, Bull. Electrochem, **20**, (2004), pp 63.
16. P. Choudhary, Y. Jain, M.K. Rathoria and S.P. Mathur, Bull. Electrochem, **20** (2004) pp 67.
17. H. Ashassi-Sorkhabi, S. Mirzaee, T. Rostamikia and R. Bagheri, Int. J. Corros., Vol. 2015, Article ID 197587.

Scanned with OKEN Scanner

18. R. Saratha and V.G. Vasudha, E-Journal of Chemistry, **7 (3)** (2010) pp 677-684.
19. O.K. Abiola, J.O.E. Otaigbe, Corros. Sci. **51** (2009), pp 2790-2793.
20. M.A. Quraishi, D.K. Yadav, I. Ahamad, open-Corros. J. **(2)** (2009), pp 56-60.
21. P. Bothi Raja, M.G. Sethiraman, Mater. Lett. **62**, (2009), pp 2977-2979.
22. M.Dahmani, A. Et. Touhami, S.S. Al-Deyadd, B. Hammouti, A. Bouyanzer, Int. J. Electrochem Sci., **5**, (2010), pp 1060-1069.
23. E. A. Noor, J. Eng. Appl. Sci. **3**, (2008), pp 23-30.
24. V,. Sribharathy and Susai Rajendran, ISRN Corrosion, Vol. 2013, Article ID 370802.
25. S. Rajendran, S. Shanmugapriya, T. Rajalakshmi and A.J. Amalraj, Corrosion, **61 (7),** (2005), pp 685-692.
26. S. Rajendran, J. Aroiaselvi and V. Gangasree, Portugalia Electrochemicia Acta, **27 (2),** (2009) pp 1-11.
27. C.A. Loto, Nigerian Corrosion Journal, **19** (1998), pp 20-28.
28. J. Buchweishaija, Tanz. J. Sci. **35** (2009), pp 93-105.
29. A.O. Odiongenyi, I.S. Enengedi, I. Ibok, E.J. UKpong, Int. J. Chem, Material & Environmental Research (2015).
30. Sudesh Kumar & S.P. Mathur, ISRN Corrosion, Vol. 2013 Article ID 476170.
31. A.Y. Fl-Etre, M. Abdallah, Z.E. El-Tantawy, Corrosion Science, **47 (2),** (2005), pp 385-395.
32. Abd. Et. Aziz S. Fouda, Ahmed Abdel Nazeer, Mohamed Ibrahim and Mohamed Fakih, J. of the Korean Chemical Society, **57 (2)** (2013).
33. M.A. Quraishi, A. Singh, V.K. Singh, D. K. Yadav, A.K. Singh, Mater. Chem. Phys., **122** (2010), pp 114-122.
34. L.R. Chouhan and G. Gunasekaran, Corrosion Science, **49 (3)**, (2007), 1143-1161.
35. M.G. Sethuraman and P. Bothi Raja, Pigment Resin Technol. **34** (2005), pp 327-331.
36. P. Matheswaran, A.K. Ramasamy, E.J. Chem. **9** (2012), pp 75-8.
37. M. Shayamala and P.K. Kasthuri, Int. J. Corros. Vol. 2011, Article ID 129647.
38. Gargi Jain and Pankaj Gupta, IJSRR, **3 (4)**, (2014) pp 72-83
39. A.Y. El-Etre, Corrosion Science, **45**, (2003), pp 2485

Scanned with OKEN Scanner

40. G.Ji, S.K. Shukla, P. Dwivedi, S. Sundaram, R. Prakash, Ind. Eng. Chem. Res. **50 (21)**, 2011, PP 11954-11959.
41. T. Jain, R. Chowdhry, P. Arora, S.P. Mathur, Bull. Electrochem, **21**,(2005), PP 23-27.
42. E.E. Ebenso, U.J. Ekpe, U.J. Ibok, S.A. Umoren, E. Jakson, N.C. Oforka, O.K. Abiola, S. Martinez, Trans. SAEST, **39**, 2004, pp 117-123.
43. S.L.A. Priya, A.A. Chitra, S.A. Rajendram, K.B. Anuradha, Surf. Eng., **21**, 2005, pp 229-231.
44. A.A. El-Hosary, R.M. Saleh, A.M. Shams El-din, Corros. Sci. **12**, 1972, pp. 879-904.
45. G.D. Davis, J.A. Von Fraunhofer, Mater. Perform, **42**, 2003, pp. 56-60.
46. O.K. Abiola, N.C. Oforka, E.E. Ebenso, N.M. Nwinuka, Anti-Corros. Methods Mater. **54**, 2007, pp. 219-224.
47. A. Singh, E.E. Ebenso, M.A. Quraishi, Int. J. Electrochem. Sci., **7 (4)**, 2012, pp. 3409-3419.
48. P. Bothi Raja and M.G. Sethuraman, A. Review. Mater. Lett. **62**, 2008, pp. 113-116.
49. S.K. Sharma, A. Mudhoo, E. Khamis, J. Corros. Sci. Eng. 2009.
50. Abd. El-Aziz, S. Fouda, A.A. Nazeer, M. Ibrahim and M. Fakih. J.Korean. Chem. Soc., **57 (2)**, 2013.
51. G. Khan, K.M.S. Nawaz, W.J. Basirum, H.B. Mohd. Ali, F.L. Farej, G.M. Khan, Int. J. Electrochem. Chem. **10**, (2015), pp 6120-6134.
52. M. Sangetha, S. Rajendran, J. Sathiyabama, T. Uma Sankereswari, A. Krishnaveni and R.M. Joany, Int. J. of Nano. Corrosion Sci. and Eng., **2 (3)**, (2015), pp 14-21.
53. V. Johnsirani, S. Rajendran, A. Christy, C. Mary, R.J. Rathish, T. Umasankareswari and J. Jeyasundari; Int. J. Nano Corros. Sci. and Eng., **2 (3)**, (2015), pp. 22-28.
54. X. H. Li, H. Fu, S.D. Deng., Corros. Sci., **62**, 2012, pp. 163-75.
55. X. H. Li, H.Fu, S.D. Deng, J. Chin, Soc. Corros. Prot. **21**, (2011) pp. 75-8.
56. S.K. Sharma, A. Mudhoo, Gargi Jain and Jyoti Sharma, Green Chem. Letters and Reviews, **3 (1)**, (2010), pp. 7-15.

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57. J. Dubey, P.Sharma, A. Chaturvedi, R.K. Upadhyayh, J. Corros. Sci. Eng., **13**, 1, (2010).
58. M.A. Quraishi and R. Sardar, Corrosion, **58 (2)** (2002), pp. 103-107.
59. E.E. Ebenso and P.C. Okafor, Anti-Corros. Meth. and Mater., **50**, (2003), pp. 414.
60. R.K. Upadhyay, S. Anthony and S.P. Mathur, Polish J. of Chem. **43**; (2007), pp 238.
61. T. Sethi, A. Chaturvedi, R.K. Upadhyay and S.P. Mathur, Polish. J. of Chem., **82**, (2008), 591.
62. S.M. Bhola, G. Singh and B. Mishra, Int. J. Electrochem. Sci. 8, (2013), pp 5635-5642.
63. M. Abdul-Gawad, M. Issay, S.M. Abd. Alhamid, Egypt, J. Pharm. Sci., (1993), pp 34-219.
64. H. Ashassi- Sorkhabi, B. Shaabani, Appl. Surf. Sci.; **239 (2)**, (2005), pp. 154-164.
65. I. Ahmad, R. Prasad, M.A. Quraishi, Corros. Sci. **52 (3)**, (2010), pp. 933-942.
66. S. Safak, B. Duran, A. Yurt; G. Turkoglu. Corros. Sci. **54**, (2012), pp 251-259.
67. M.A. Quraishi and S. Khan, Ind. J. Chem. Technol; **12**, (2005), pp 576.
68. M.A. Quraishi, I. Ahmad, A.K. Singh, S.K. Shukla, B. Lal and V. Singh, Mater. Chem. Phy. **112**, (2008), pp. 1035.
69. S.M. Bhola, G. Singh and B. Mishra, Int. J. Electrochem Sci. 8,(2013), pp. 10851-10863.
70. S.S. Singh, S.C. Pandey, S.Srivastava, V.S. Gupta, B. Patro, A.C. Gosh, Indian J. of Pharmacology, **35**, (2003), pp. 83-91.
71. N.M. Reddy, Rajasekhar Reddy, Sch. Acad. J.Pharma, **4 (8)**, (2015), 364-369.
72. A.S. Yaro, A.A. Khadom, H.F. Ibraheem, Anti Corros. Meth Mater. **58**, (2011) pp. 116-124.
73. J.D. Talati and D.K. Gandhi, Indian J. Tech. **29**,pp (1991), 277.
74. P.sharma, R.K.Upadhyay and A.chaturvedi, Elixir corrosion. **46**(2012), pp.8382-8385.

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CERTIFICATE BY SUPERVISOR

Certified that :

1. I am willing to guide the research work of **Ms. VINEETA MANDAWARA** on the above subject If she is registered for Ph.D.
2. To the best of my knowledge the subject selected has not been studied so far in any University.
3. The subject is of sufficient scope to keep the candidate engaged for two years.
4. The subject will lead to a valuable contribution. I have seen and approved the out line and bibliography etc. submitted by the candidate.

5. Necessary facilities are available in the department for the above research work (Certificate from Principal/Head University Department with regards to facilities available is enclosed)

6. I have 06 research candidate registered under my supervision and the serial number of this candidate whose application being forwarded for registration is 07.

7. The candidate is not in a close relation (the term close relation is defined in examination ordinance of the university).

Signature of the Supervisor.....
with date 20/7
Lecturer.....
Samrat Prithviraj Chauhan
Govt. College, Ajmer

Certified that the available facilities will be extended to **Ms. VINEETA MANDAWARA** for research work if she registered for Ph.D.

Signature of the Principal/
Director of the Institute
with date

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